Expert Report

Addressing Potential Health Concerns Associated With Inhalation of Zonolite™ Attic Insulation

by

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3208 Bennett Point Road
Queenstown, Maryland 21658-1126

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Table of Contents

I. Background.

I have been asked by Richard C. Finke, Senior Litigation Counsel, W.R. Grace & Co. to evaluate the potential exposure and risk to the health of occupants of homes in which there is Zonolite™ Attic Insulation (ZAI). Also, I have been asked to place this exposure, if any, in perspective vis-à-vis past occupational asbestos exposures and exposures of occupants of schools and commercial buildings containing Asbestos –Containing Materials (ACM). I was also asked to evaluate the potential exposures resulting from remodeling of homes with ZAI; exposures of occupants and/or remodelers.

II. Qualifications.

I am a Professor Emeritus of Environmental Health Engineering in the Bloomberg School of Public Health of the Johns Hopkins University and President, Morton Corn and Associates, Inc., a consulting firm that works out of my home in Queenstown, Maryland. Environmental health engineering is a discipline concerned with the evaluation of air, water, soil and materials in our environment and the interventions to improve them if they are found to be unhealthy or to pose a human health risk. I received a Bachelor's degree in Chemical Engineering from the Cooper Union School of Engineering in 1955, a Master of Science degree in Industrial Hygiene and Sanitary Engineering from Harvard University in 1956, and a Doctor of Philosophy degree in Industrial Hygiene and Sanitary Engineering from Harvard University in 1961. The subject of my doctoral dissertation was the adhesion and re-entrainment of particles from surfaces. This contribution to basic science is relied on today by engineers and scientists who are dealing with indoor air quality concerns.

From October 1975 until January 1977, I served as Assistant Secretary of Labor for Occupational Safety and Health. I have provided consultation services to many private and governmental organizations, including the United States Atomic Energy Commission, the United States Public Health Service, the United States Bureau of Mines, the World Health Organization, the United States Department of Energy, the United States General Services Administration, the United States Environmental Protection Agency, the National Institute of Environmental Health Sciences, Harvard University School of Public Health, the American Petroleum Institute, Pennsylvania State University, and the Brookings Institution. As a consultant to the United States Environmental Protection Agency (EPA), I served on its Science Advisory Board (SAB) from 1977 to 1984. The SAB reviewed the Agency's Health Assessment document for asbestos.

Included in the awards I have received is the Cummings Award, which is given once a year by the American Industrial Hygiene Association for outstanding contributions in the field of industrial hygiene. My Cummings Award Lecture was on Asbestos and Public Health. (Corn, M., "Asbestos and Disease: An Industrial Hygienist's Perspective," Am. Ind. Hyg. Assoc. J., 47(9), 515-23 (1986)). I have published more than one hundred peer-reviewed articles, fifteen or more chapters in books, and edited three books. In 1994, I received the Smyth Award of the American Academy of Industrial Hygiene, an annual award for outstanding contributions to industrial hygiene. In 2000 I was elected a Director on the Board of the American Industrial Hygiene Association and will serve for three years. In

June, 2001 at the annual Industrial Hygiene Conference and Exposition I received the Meritorious Achievement Award of the American Conference of Governmental Industrial Hygienists. It is presented once a year for "outstanding, long-term contribution to the field of occupational health and industrial hygiene."

I have measured asbestos-in-air in glass, steel, and insulation manufacturing facilities during the 1950's, 1960's, 1970's, and have designed ventilation systems to capture potentially toxic dusts and gases from processing operations. I taught graduate courses at Johns Hopkins University and the University of Pittsburgh in the subject areas of industrial hygiene, air pollution, industrial ventilation, aerosol technology and risk assessment.

I have conducted extensive research on airborne asbestos concentrations in buildings as it relates to occupants and to workers who work with or near asbestos-containing materials and have published many of these studies. (see e.g., Mlynarek, S., Corn, M., and Blake, C., "Asbestos Exposure of Building Personnel," Reg. Tox. & Pharm. 23(3) 213-224 (1996); Corn, M., et al., "Asbestos Exposures of Building Maintenance Personnel," Appl. Occup. Env. Hyg. 9(11), 845-852 (1994); Corn, M., "Airborne Concentrations of Asbestos in Non-Occupational Environments," Ann. Occup. Hyg. 38(4), 495-502 (1994); M. Corn, et al., "Exposure to Airborne Asbestos in Buildings," Reg. Tox. & Pharm. 16, 93-107 (1992); M. Corn, et al., "Airborne Concentrations of Asbestos in 71 Buildings," Reg. Tox. & Pharm.13, 99-114 (1991); Corn, M., et al., "Asbestos: Scientific Developments and Implications for Public Policy," Science 247, 294-301 (1990); Esmen, N.A. and Corn, M., "Airborne Fiber Concentrations During Splitting Open and Boxing Bags of Asbestos," Tox. and Ind. Hlth. 14(6), 843-856 (1998). I have participated in numerous United States and international scientific, industrial hygiene, and public health conferences. For example, I participated in the Workshop on the Biological Effects of Fibers organized by the International Agency for Research on Cancer held in Lyon, France in June 1977, was an invited speaker and session chairman at the International Conference on Biological Effects of Man-made Mineral Fibers held in Copenhagen, Denmark in 1982, and have been invited by the federal government to comment on regulatory rule-makings concerning asbestos.

My Curriculum Vitae is attached as Exhibit A. My fee for professional consulting services, including expert consultation and testimony in litigation, is $3600 per day or $450 per hour. I have been accepted as an expert in various federal and state courts to testify in asbestos property damage and premises liability cases, and in other litigation.

III. Case Specific Materials Cited Herein.

- Lees, P.S.J. and Mlynarek, S.P.: Assessment of Potential Asbestos Exposure Resulting from Disturbance of Zonolite™ Vermiculite Attic Insulation, January 9, 2003. Submitted to R.C. Finke, Senior Litigation Counsel, W.R. Grace Co. The videos of these investigations were also reviewed.

- Anderson, E.L.: Review of Current Exposures and Current Health Risks Associated With Asbestos Exposure in Libby, Montana. Science International, Inc. July 29, 2002.

- Anderson, E.L.: Supplemental Report to Address Potential Risks Associated With Vermiculite Attic Insulation in Libby, Montana. Science International, Inc. Sept. 2, 2002.

- Anderson, E.L.: Analysis of the Risk Assessment Information to Support Cleanup Decisions Made by the EPA Region 8 at the Libby, Montana Asbestos Site. Science International, Inc. Aug. 30, 2002. Prepared for W.R. Grace Co., Holme Roberts & Owen LLP.

- Versar, Inc.: Preliminary Draft of Asbestos Exposure Assessment for Vermiculite Attic Insulation (Cumulative Study Covering Research Conducted in 2001 and 2002), June 28, 2002. Prepared for Office of Pollution Prevention and Toxics, USEPA, Wash., D.C.

- Moolgarkar, S.H.: Expert Report on the Relative Toxicity of Libby Amphibole Asbestos Fibers. July 29, 2002. Submitted in the Libby cost recovery litigation.

- Pinchin Environmental: Final Report. Site Assessment Vermiculite Removal Bldg. E-12, C.F.B. Shiloh, Shiloh, Manitoba. April 3, 1997. Prepared for Dept. of National Defense, Base Construction Engineering, Canadian Forces Base Shiloh, Shiloh, Manitoba ROK2AO.

- Agency for Toxic Substances and Disease Registry, U.S. Dept. of Health and Human Services. Atlanta, Georgia 30333. Report titled Preliminary Findings of Medical Testing of Individuals Potentially Exposed to Asbestiform Minerals Associated With Vermiculite in Libby, Montana: An Interim Report for Community Health Planning. February 22, 2001.

- U.S. Environmental Protection Agency. EPA Response to September 11. EPA-OSHA Fact Sheet: Environmental Information from Lower Manhattan for Residents, Area Employees and Local Business Owners. Data through Sept. 30, 2001.

- Ibid. U.S. Environmental Protection Agency Testing Criteria and Limits. Testing Criteria and Limits.

- U.S. Environmental Protection Agency. Memorandum dated April 24, 2002 from Christopher P. Weis to Paul Peronard titled Addendum Supporting and Clarifying the Libby Risk Memo of December 20, 2001 and Associated Libby Risk Memos.

- U.S. Environmental Protection Agency. Memorandum dated December 20, 2001 from Christopher P. Weis to Paul Peronard titled Amphibole Mineral Fibers in Source Materials in Residential and Commercial Areas of Libby Pose an Imminent and Substantial Endangerment to Public Health.

- U.S. Environmental Protection Agency. OPPT Comments on Action Memorandum Amendment Removal Action at the Libby Asbestos Site. February 22, 2002.

- U.S. Environmental Protection Agency. Memorandum dated 11/22/02 from Chris P. Weis to Paul Peronard Re: Revised Screening Risk Estimates.

- Preliminary Findings of Medical Testing of Individuals Potentially Exposed to Asbestiform Minerals Associated with Vermiculite in Libby, Montana: An Interim Report for Community Health Planners. U.S. Dept. HHS, Atlanta, GA. Feb. 22, 2001. Also critique of report by G.M Marsh.

IV. The Industrial Hygiene Approach to a Potential Health Risk.

A very well known paradigm or model in the occupational and environmental health field is that of the industrial hygienist. This model includes recognition, evaluation and control of the potentially hazardous material. (Corn, M.: "The Role of Control Technologies in Preventing Occupational Disease," Arch. Env. Health 39, 235-240 (1984)).

a. Recognition

Recognition is associated with confirmation that a material is potentially toxic and that it is, indeed, present. Epidemiological studies have established that workers in mines, mills, shipyards, and other asbestos workplaces of the past who were exposed to high levels of airborne asbestos for prolonged periods of time were at high risk of contracting asbestos-related diseases, and did, indeed, contract disease in significant numbers. What, if any, risk is presented by exposure to asbestos at ambient levels or at the levels permitted by current occupational regulations is not known and can only be estimated statistically because there is no epidemiological experience with lifetime exposures of working populations at current very low permissible exposure concentrations compared to past exposure concentrations. Using very prudent models to estimate risk, it is judged to be low, if it exists at all. The presence or not of asbestos and its relative abundance or concentration is determined by appropriate sampling and analysis in the evaluation phase of the model.

b. Evaluation

The evaluation portion of this paradigm refers to measurement. It is measurement of the potentially toxic material that differentiates the professional industrial hygiene approach from that which may have been used or is used by others. The professional industrial hygiene approach utilizes a set of guidelines such as those of the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV's), or a set of standards enforceable by law under the Occupational Safety and Health Act as the basis for evaluating the particular environment. These Occupational Safety and Health Standards contain Permissible Exposure Limits (PEL's) for Airborne Agents. Air sampling is used to assess whether exposures are within TLV's or PEL's, and no surrogates are permitted as substitutes for air sampling measurements.

The Occupational Safety and Health Administration (OSHA) PEL's are the dividing line between legally acceptable and non-acceptable conditions. These evaluations are performed by professionals who must make some judgments about the environment. It is clear from both the ACGIH statement of the TLV's, and the manner in which OSHA PEL's are enforced by OSHA's Compliance Health and Safety Officers, that there are judgment factors involved (Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment with Intended Changes for 2002. American Conference of Governmental Industrial Hygienists. Cinn., Ohio 1996)). The PEL's, or in their absence, guidelines, are the basis for acceptability or non-acceptability of the measured airborne concentrations.

It is important to understand that these standards or guidelines are, as the ACGIH indicates, concentrations at which "nearly all workers can be employed for their entire working lifetime without adverse effect." (TLV's, ACGIH, Cinn., Ohio, 1996). For the OSHA PEL's, the standard applies to 45 years of a working lifetime, 50 weeks a year, 40 hours per week. Using prudent statistical models, the PEL is not deemed to be risk free, but it is deemed to be sufficiently low risk to be acceptable. Also, it is unlikely that very many people will be occupationally exposed for 45 years to asbestos in air. For this reason and others discussed below, it will be seen that utilizing the OSHA PEL for evaluation of building maintenance worker or home remodeler exposure is a very conservative approach.

In approaching the evaluation portion of the model, the professional hygienist or environmental engineer is in a difficult position with respect to occupants or non-employed persons in buildings or homes because there is no federal government standard or guideline. In this case, the clearance concentration for asbestos in air has been used. It is required by the Environmental Protection Agency (EPA) for permitting occupants of buildings to reenter the building after asbestos-containing materials have been abated. This concentration is 0.01 fibers per cubic centimeter of air. The criterion is applied utilizing the methodologies of the electron microscope to identify specific asbestos fibers. (Yamate, G., Aqasual, S.C. and Gibbons, R.D.: Methodology for the Measurement of Airborne Asbestos by Election Microscopy. Contract 68-02-3266. U.S.E.P.A., Wash., D.C., (1984)). An initial risk-based clearance criteria of 0.0009 f/cc was publicized by the EPA after the 9-11-01 attack on the World Trade Center in New York City. (U.S. EPA Response to September 11: Testing Criteria and Limits). However, to the best of my knowledge, this guideline was not implemented; instead, the 0.01 f/cc building asbestos abatement clearance criterion was invoked.

It is also important to note that the OSHA PEL, which is applicable to maintenance persons working in buildings, was adopted mainly for general industry and for employees who are working with raw asbestos or with products containing substantial percentages of asbestos. In contrast to the EPA clearance methodology referred to above, the OSHA methodology to evaluate asbestos fibers in samples of air does not differentiate between asbestos fibers and other fibers*. The method was developed for air in asbestos factories, where the vast

*NIOSH, Method for Determination of Asbestos in Air Using Phase Contrast Microscopy. NIOSH Method 7400. Issued 15 February 1974. Revised 15 May 1989. U.S. Dept of Health and Human Services, National Institutes for Occupational Safety and Health. Cinn., Ohio.

majority of fibers were asbestos. When this methodology is utilized to evaluate the exposure of maintenance workers or occupants in buildings or homes, it has a built-in safety factor because there are many non-asbestos fibers present in the environment of buildings, including, but not restricted to other fibers in the ACM product and fibers associated with carpets, curtains, clothing and fibrous glass products in buildings or homes. Thus, when all fibers are measured, quantitated as "concentration of asbestos fibers in air" and compared to the OSHA PEL, any apparently "high" concentration in buildings or homes most likely results from counting non-asbestos fibers, in addition to asbestos.

c. Control.

The third ingredient of the paradigm that the professional industrial hygienist or environmental engineer follows is that of control. How do we control exposures to potentially toxic materials? There is a host of possible approaches to control, numbering in excess of 21 interventions. (Corn, M., "Assessment and Control Environment Exposure," Allergy Clin. Immun. 72, 231-241 (1983); Corn, M.; "The Role of Control Technologies in Preventing Occupational Disease," Arch. Env. Hlth. 39, 235-240 (1984)).

The guideline for application of controls is referred to as the "Hierarchy of Controls." Appropriate levels of control are chosen based on sound professional evaluation of the exposure circumstances to be controlled. In general, there is an effort to utilize engineering controls to deal with potential industrial hazards when the evaluation indicates that the condition is not acceptable. Engineering approaches include: substitution for the product, ventilation controls, isolation and enclosure. In work with asbestos-containing materials in buildings and homes, I have, in my scientific and professional judgment, rejected engineering-type controls because the exposure conditions for all individuals potentially exposed to asbestos-containing materials in buildings and homes are acceptable. Occupants of buildings and homes, and maintenance personnel, as will later be discussed are not at unacceptable risk from inhalation of asbestos in building air. The engineering solution of ACM removal in buildings and homes is often a greater risk to persons involved in the removal and also may create a higher concentration of asbestos in air in the building or home than was originally present before the removal occurred. Furthermore, the acceptable re-occupancy concentration of asbestos-in-air enforced by the EPA, i.e., 0.01 f/cc, is higher than the asbestos-in-air concentrations in buildings and homes with ZAI before removal. Thus, the removal option should be exercised only under certain very specific conditions, which will later be addressed.

V. Application of the Industrial Hygiene Approach to Vermiculite Attic Insulation.

A. Recognition.

1. Asbestos in Zonolite™ Attic Insulation (ZAI).

Zonolite™ Attic Insulation asbestos content was determined by Versar, Inc. and reported in the Preliminary Draft Report "Asbestos Exposure Assessment for Vermiculite Attic Insulation (June 2, 2002). Samples were obtained from:

- Vermiculite insulation products purchased from stores throughout the U.S.
- Old bags of Zonolite™ insulation obtained by EPA Region 10 from Seattle Public Utilities and homeowners (it is not known if these were manufactured by W.R. Grace before the Libby Mine was closed in 1990).
- Vermiculite attic insulation currently installed in residential houses in Vermont.

The asbestos content of these materials was determined by both Polarized Light Microscopy (PCM) and Transmission Electron Microscopy (TEM). Results of this investigation indicated that:

- Asbestos fibers were not detected in any of the bulk samples obtained from five products purchased from stores.
- Five Zonolite™ products acquired through EPA Region 10 were comprised of three products from Seattle Public Utilities in Penton, Washington and two partially used bags of Zonolite™ from residential homes in Washington State. The asbestos content of these five materials varied from non-detect to 0.13 percent actinolite.
- Bulk samples of ZAI from five occupied houses in Vermont ranged from 1-2% tremolite in 24 samples.

The asbestos content of vermiculite removed from a World War II era building in Shiloh, Manitoba was less than 0.1% asbestos (Final Report: Site Assessment Vermiculite Removal, Building E12, C.F.B. Shiloh, Shiloh, Manitoba by Pinchin Environmental).

These measurements are consistent with the understanding that while Vermiculite ore contains fifteen or more percent asbestos, the exfoliated ZAI contains asbestos at approximately 1% or less by weight. Whether the asbestos content of ZAI is trace quantity, 1% or 2% by weight, this percentage formulation of a potentially toxic substance in a bulk solid is designated by hygienists as "low" content. It is generally assumed that the higher the bulk material content, the higher the potential for the toxic ingredient to become airborne. A point of reference for this issue is that the OSHA Permanent Standard for Asbestos in the Workplace and EPA regulations pertain to products containing 1% or more by weight of asbestos. "Low" content of bulk material results in minimal airborne material.

2. Nature of ZAI.

ZAI is loose fill. It is capable of producing dust upon application of energy causing movement of the bulk material, for example during pouring.

B. Evaluation.

1. Qualitative Aspects.

Prior to the Hearing in Marco Barbanti, et al., vs. W.R. Grace & Co., et al., I was asked to inspect homes in the Seattle area and in Montana in order to better understand the potential for exposure of occupants to ZAI. My notes on these inspections are in Appendix B. I presented my opinions on the potential for exposure of home occupants to ZAI at the Hearing held on November 30, 2000. In addition to on-site observations, measurements of airborne concentrations of asbestos and asbestos content of the bulk ZAI in the homes were available.

I observed ZAI sealed between attic floor joists and floorboards and visible ZAI between attic joists. I observed ZAI beneath and above add-on fibrous glass batts and blown-in fiber. There were attics never accessed, attics occasionally accessed and, in one case (with ZAI beneath the attic floor) an attic serving as a bedroom. My conclusion was that the duration of any homeowner or occupant exposure to ZAI was brief and intermittent even for those utilizing the attic as a bedroom. In the one case of bedroom usage, the ZAI was essentially enclosed beneath the floor and did not offer dust emissions to attic air, or any exposure opportunity.

In addition to these observations, analyses of the bulk ZAI asbestos content and samples of attic air obtained under non-disturbance conditions were available. The former ranged from trace amounts to one percent asbestos, while the latter were less than the EPA clearance concentration of 0.01 f/cc.

I testified that, in my opinion, the ZAI did not pose a health risk to home occupants. Declaration of a public health emergency, requested by plaintiffs was unwarranted and not defensible based on the evidence.

An issue arising from this Hearing was the potential of home remodelers, who intrude on ZAI, for occupational asbestos exposure. A related issue was the effect on home air and occupant exposure of the remodeling itself. I indicated that data were needed to place these issues in better perspective, but based on the asbestos in buildings concern that had been resolved, I did not anticipate a hazard.

2. Quantitative Aspects.

Since the Barbanti Hearing additional data on exposure to asbestos from ZAI have become available. In particular, simulations of activities disturbing ZAI have been conducted with associated air sampling to assess exposure. These data will be briefly summarized as part of the evaluation phase of ZAI potential health risk.

a. Lees, P.S. J. and Mlynarek, S.P.: Assessment of Potential Asbestos Exposure Resulting from Disturbance of Zonolite™ Vermiculite Attic Insulation. Jan. 9, 2003.

This is the most extensive investigation of home occupant exposure to asbestos in air from the presence and disturbance of ZAI. The effects of a variety of household activities, including repair and renovation tasks were studied. Tests were performed in a home containing ZAI installed in1971 to a depth of four to five inches between ceiling joists. The attic did not have flooring over the ceiling joists and materials were not stored in the attic.

The ZAI was sampled at depths designated "top," "bottom" and "middle" at several locations and samples were analyzed by Polarized Light Microscopy (PLM) for asbestos content after separating the samples by size (greater and less than 500 microns (um)). The results of analyses by location, expressed by combining the three depth samples at a location, varied from 0.5% to 0.95% asbestos by weight for four samples and 2.59 weight percent for one sample.

Background air samples, in the house and outdoors, were less than 0.005 f/cc determined by TEM analysis for task time durations. On an 8-hr Time Weighted Average (TWA) basis, all samples were less than 0.001 f/cc by TEM analysis.

Personal and area air sampling was performed during task activities of moving boxes in the attic, small area clearance of ZAI and refill, small area clearance of ZAI and ceiling fan installation, and large area clearance of ZAI and refill and box removal, cleaning and vacuuming. Tasks and sampling were replicated. Task times ranged from 21 to 189 minutes. Air samples were analyzed by both PCM and TEM.

Asbestos in air personal exposure concentrations during task activities varied from a high of 0.20 f/cc (less than 0.009 TWA) to less than 0.025f/cc (less than 0.009 f/cc TWA) by TEM. Results of personal sample PCM analyses varied from 1.2 f/cc (0.054 TWA) to 0.076 f/cc (0.004 f/cc TWA). These ranges of results encompass workers and bystanders during task performance. Results vividly illustrate the difference between PCM, which counts all fibers, and TEM, which identifies asbestiform fibers and counts only those fibers. The results also contrast the 8-hr Time Weighted Average exposures and those associated with the task performance duration.

b. Environmental Protection Agency, Region VIII. Memorandum "Addendum Supporting and Clarifying the Libby Risk Memo of December 20, 2001 and Associated Risk" by C. Weis.

Results of air sampling in residences and at outdoor locations in Libby, Montana are presented. Asbestos-in-air concentrations are expressed as PCME, or Phase Contrast Microscopy Equivalents, based on TEM, as well as PCM results. The

methods utilized to obtain these results have been critiqued by R.J. Lee in an Expert Report for the Libby Cost Recovery Case (2000) and by E.L. Anderson in a report "A Review of Current Exposures and Current Health Risks Associated With Asbestos Exposure in Libby, Montana" (July 29, 2002). If these critiques are ignored, the summary data in the Memo (Table 8) indicate one out of 122 personal samples during active cleaning and two out of twenty two during simulated remodeling exceeded the OSHA PEL of 0.1 f/cc longer than five microns 8-hr TWA. For routine activities none of nine personal samples and none of five samples for roto-tilling exceeded this standard. If the critiques are accepted as valid, and I believe they are, there would not be any exceedance of the OSHA 8-hr TWA PEL; i.e. reported exposures would be much lower. Perhaps the most significant criticism of this investigation is that TEM analysis of air samples utilized the indirect sample preparation methodology, which has been demonstrated to degrade asbestos captured on air sample filters and to very significantly increase asbestos fiber counts. However, there are numerous other problems with the data presented, as addressed in the critique by E.L. Anderson.

c. Preliminary Draft Report "Asbestos Exposure Assessment for Vermiculite Attic Insulation: Cumulative Study Covering Research Conducted in 2001 and 2002." Versar, Inc. 6850 Versar Center. Springfield, VA 22151. Prepared for Office of Pollution Prevention and Toxics. U.S. Environmental Protection Agency. June 28, 2002.

This investigation included airborne asbestos concentration measurements associated with simulated activities with ZAI performed in a containment chamber, as well as measurements during activity simulations in five unoccupied Vermont houses. Simulated activities which disturbed ZAI included removing dry ZAI, cutting a hole in the below attic ceiling from the attic and from the room below the attic. ZAI removal was by a homeowner and by a contractor. Twenty-five of twenty-nine bulk samples indicated less than 1% asbestos content; four samples contained 2% asbestos by weight.

Background and post-simulation area air samples were collected for four homes; personal or area air samples during simulation activities were collected for 30 minutes. It is interesting that exposure results for Phase 1 of this study, those obtained in a simulated attic, were significantly higher than those obtained during Phase 2, measurements of activities in unoccupied Vermont homes, suggesting that there was air infiltration in homes that did not occur in the attic containment. Significant findings of this study were, as could be expected, 30 minute exposure concentrations during ZAI disturbance and hole cutting were elevated during the period of disturbance. Concentrations determined by TEM following indirect sample preparation, were as high as 2.6 f/cc greater than 5 microns in length (one sample). A companion sample to this high result was 0.2 f/cc. In general, in contrast to short term (30 minute) results in the containment zone of ZAI disturbance, simultaneous air sampling throughout the house in which the tests were performed indicated that asbestos-in-air concentrations were not elevated. It

should again be noted that the analytical methodology for TEM analyses in these tests was the indirect preparation technique.

A large number of air samples were collected in this study. Rather than attempt to summarize all of the results, a summary paragraph in the Discussion section of the report will be reproduced here in its entirety.

The findings of the study are summarized here as follows:

1. Disturbances of vermiculite insulation by homeowners (e.g. via homeowner repairs or remodeling) can result in asbestos exposure via inhalation of airborne fibers. The risks associated with single or infrequent exposure of this kind are within or below EPA's target risk range of $1x10^{-6}$ to $1x10^{-4}$ based on the limited sampling of vermiculite products tested in this study.

2. Similar exposures can occur among homeowners who remove the insulation themselves.

3. These exposures can be mitigated to a certain extent by wetting the insulation before disturbing it.

4. Vermiculite attic insulation can be removed safety (i.e. without generating airborne asbestos) by a qualified contractor and

5. Blower door tests such as those performed by Vermont Gas can be done without generating airborne fibers.

As will be discussed later in this report (Section VIII), the potential health risk from inhaling airborne asbestos is dependent not only on the concentration of asbestos in the inhaled air, but also on the duration of time the asbestos-in-air is inhaled. The authors of this report clearly recognized that the elevated exposure to asbestos occurred only to those in the immediate vicinity of the ZAI disturbance, and that such disturbances were infrequent.

d. Final Report. Site Assessment Vermiculite Removal Building E-12, C.F.B. Shiloh, Manitoba. Pinchin Environmental. April 3, 1997.

The purpose of this assessment was to determine the safety of removing the ZAI in several buildings with standard demolition procedures, i.e. without taking asbestos precautions in Building E-12, a World War II era one story wood frame building with drywall ceilings and vermiculite loose fill insulation in the attic space. Building demolition is an extremely disruptive procedure creating excessive dust. Results confirmed that standard asbestos removal precautionary procedures are required during demolition of buildings with ZAI in order to avoid exposures of workers and bystanders. However, analytical methodological

problems resulted, in my opinion, in airborne asbestos concentrations an order of magnitude higher than results of other, earlier asbestos removal studies.

Expert reports and associated data, as well as videos by W. Longo, R. Hatfield, W. Ewing and Gobbel-Hays were received after completion of this report, too late to address in this report. They will be addressed.

3. Standards and Guidelines.

Unfortunately, a U.S. Standard for non-occupational exposure to asbestos-in-air does not exist. The closest guideline to a non-occupational standard is the EPA clearance concentration associated with permitting building re-occupancy after bulk asbestos abatement. This guideline is 0.01 f/cc determined by TEM. This clearance standard involves the general public and suggests that a long-term 0.01 f/cc asbestos-in-air concentration is deemed acceptable in the long-term for occupants of public and private buildings.

The occupational asbestos (all forms) Permissible Exposure Limit enforced by OSHA is 0.1 f/cc 8-hr TWA for fibers greater than five microns length by PCM. It applies to healthy adult workers and is permissible 40 hours per week, fifty-two weeks per year for a 45-year working lifetime.

The Threshold Limit Value guideline for all forms of asbestos by the American Conference of Governmental Industrial Hygienists is 0.1 f/cc for fibers greater than five microns length, determined by PCM. This occupational exposure guideline is the same as the OSHA PEL.

C. Control.

In the absence of ZAI disturbance in homes, controls are not deemed necessary. Asbestos in-place, undisturbed is not a hazard, as EPA found for asbestos in buildings and explicitly stated in the "Green Book" (1990). On those occasions in homes where remodeling occurs, ventilation utilizing windows and fans, as well as respirators should be utilized by remodelers, the same precautions I would recommend in any dusty environment

VI. Relevant Lessons Learned From the U.S. Asbestos-Containing Materials In Schools and Buildings Experience, 1979-91.

The Environmental Protection Agency, in a series of guidance documents, often Referred to as the "Orange Book" (Asbestos-Containing Materials in School Buildings: A Guidance Document Part 1. U.S. EPA, Office of Toxic Substance, Wash., D.C., March, 1979.), The "Blue Book" (Guidance for Controlling Friable Asbestos-Containing Materials in Buildings. U.S. EPA, Office of Pesticides and Toxic Substances. Wash., D.C. EPA Report No. 56015-83-002. March, 1983), and the "Purple Book" (Guidance for Controlling Friable Asbestos-Containing Materials in Buildings. U.S. EPA, Office of

Pesticides and Toxic Substances. Wash., D.C. EPA Report No. 56015-85-002. June, 1985) called attention to and developed programs to address the risk to occupants of schools and buildings created by the presence of ACM in the buildings. Initially, the exposure to occupants (Orange Book) was compared to those experienced by asbestos workers in earlier years, exposures that resulted in asbestos disease. In the Blue and Purple Books, the EPA downgraded their exposure estimates to one-one hundredth and one-one thousandth respectively, those of earlier asbestos workers. In the "Green Book" (Managing Asbestos in Place: A Building Owners Guide to Operations and Maintenance Programs for Asbestos-Containing Materials. EPA Report No. 20T-2003. Wash., D.C. July 1990), the agency indicated that any risk to building occupant health from ACM in buildings is low, if it exists at all. The agency also shifted policy from a strong preference for asbestos abatement, as expressed in the earlier guidance documents, to one of management in place, in most cases. The large sums of money and effort expended on ACM in buildings, has been referred to as "Phantom Risk" (D'Agostino, R. and Wilson, R.: Asbestos: The Hazard, the Risk and Public Policy," in Phantom Risk: Scientific Inference and the Law, Foster, K., et al., Ed. 1993). Justice Breyer of the Supreme Court reached the same conclusion, that is, the minimal level of health risk from this source of asbestos, in a series of lectures presented at Howard University (Breyer, S.: Breaking the Vicious Circle: Toward Effective Risk Regulation. Harvard Univ., 1993. pp. 11-14). Scientists from the U.S., the United Kingdom and France reached the same conclusion Re: the negligible risk, if any, of asbestos in schools (Mossman, et al. "Asbestos: Scientific Developments and Implications for Public Policy." Science 247, 294-301 (1990)).

Concerns for building maintenance personnel, such as plumbers and electricians, have also been addressed (Corn, M., McArthur, B. and Dellarco, M.: "Asbestos Exposures of Building Maintenance Personnel. Appl. Occup. Env. Hyg. 9(11), 845-852 (1994); Mlynarek, S., Corn, M. and Blake, C. "Asbestos Exposure of Building Maintenance Personnel," Reg. Toxicol. Pharmacol. 23(3), 213-224 (1996)). A finding of these studies was that building maintenance workers spend only 2-4% of their work time in proximity to ACM. Another finding was that, using the PCM methodology for air sample evaluation, a methodology that counts all fibers greater than five microns length, in an environment in which other types of fibers (fibrous glass, carpet, clothing) are ubiquitous, 8-hr Time Weighted Average exposures were many times less than the OSHA PEL. Another significant study offering confirmation that work in buildings with ACM does not expose building workers to asbestos-in-air exceeding the OSHA PEL is that undertaken by the Missouri Department of Public Health (Wickman, A., Roberts, D. and Hopper, T. "Exposure of Custodial Employees to Airborne Asbestos." Bureau of Environmental Epidemiology, Missouri Department of Health. Technical Report for U.S. Environmental Protection Agency (1992).

The conclusion from analyzing maintenance exposure data of workers in buildings is that maintenance workers are not exposed to concentrations of asbestos-in-air that exceed the current OSHA PEL if relatively straight forward operation and maintenance procedures are used to reduce any fiber emission, and to protect the employee during the course of their performing work tasks.

The analogy of ACM in schools and buildings to ZAI in homes is a very close one. Occupants of schools and buildings were in building spaces below the ceilings in which ACM was located; occupants of homes live, with few exceptions, in building spaces other than the attic. Disturbance of the ACM in buildings, above the hung ceilings, resulted in somewhat elevated exposure to those causing the disturbance, but elevated asbestos in any concentrations were not detectable below the ceiling throughout the building. Similarly, studies during and after disturbance of ZAI indicated non-detectable or greatly diluted concentrations of asbestos-in-air throughout the home. Four hours after the ZAI disturbance asbestos-in-air concentrations returned to background. Furthermore, in both cases, i.e. ACM in buildings and ZAI in homes, exposures to asbestos-in-air are infrequent and at concentrations orders of magnitude below historical exposure concentrations associated with asbestos disease in workers. Thus, the integrated dosage to the lungs of those possibly exposed to infrequent, short-term elevations of asbestos-in-air in both cases, is inconsequential or non-existent in terms of asbestos health risk. This was the conclusion of the EPA in the Green Book after eleven years of investigating concerns for asbestos in buildings. The concerns for ZAI and any associated asbestos health risk appear to correspond closely to that earlier concern. The exposure measurements of occupants of homes when ZAI is undisturbed and during home remodeling appear to be the direct analogs of building occupants and maintenance personnel in buildings containing ACM, respectively.

VII. Settled Dust Measurements As a Surrogate For Personal Exposure Measurements.

Measurements of asbestos in settled dust of homes are being invoked as ZAI health concerns. Measurements of asbestos in surface, or settled dust, was a major issue addressed in asbestos in schools and building investigations. Measurements indicated that less than one percent of surface dust by weight is ACM: i.e. surface dust does not include enough asbestos to be a regulated ACM under the EPA and OSHA regulations.* Given the sample preparation techniques necessary for the analysis of settled dust by electron microscopy, this amount of asbestos by weight can be converted to a large number of fibers and the result expressed mathematically as an apparently large number of fibers per area of surface. These extraordinarily large numbers--albeit not agreed upon by different practitioners and analysts making the measurements because of different methodological approaches, initially appear to be very high and threatening. One must understand the difficulty with which settled dust can be made airborne to appreciate the lack of relevance of these measurements to inhalation risk from asbestos in air.

Six years of my professional life were devoted to investigating the adhesion and re-entrainment of particles. (Corn, M., Adhesion of Particles. Ch. XI in Aerosol Science. C.N. Davies, Ed. Academic Press London. (1966); Corn, M., "Re-entrainment of Particles from a Plane Surface," Am. Ind. Hyg. Assoc. J. 26, 325-336 (1965); Corn, M., "Adhesion of Particles to Solid Surfaces I, J. Air Poll. Control Assoc. 11, 523-528 (1961); Corn, M., "Adhesion of Particles to Solid Surfaces II, J. Air Poll. Control Assoc. 11, 566-577 (1961). Corn, M. and Stein, F.: "Mechanisms of Dust Redispersion"

*The regulations require that an ACM contain at least 1% by weight asbestos.

Proceedings of the International Symposium on Surface Contamination, Pergamon Press, New York, 1966; Corn, M. and Silverman, L., "Removal of Solid Particles from a Solid Surface by a Turbulent Air Stream," Am. Ind. Hyg. Assoc. J. 22, 337-397 (1961); Corn, M. and Stein, F., Adhesion of Atmospheric Dustfall Particles to a Glass Slide, Nature 211, 60-61 (1966)). It requires extraordinarily high forces applied to particles submerged in a viscous sub layer adjacent to the floor or ceiling tile surface to make them airborne. After they are dislodged, the larger particles are the easier ones to get aloft because their greater mass and size offers greater projected area to the moving air stream to "lift" them, as an airplane is lifted on takeoff. Those particles that are capable of being inhaled and deposited in the human lung are the particles or fibers relevant to promotion of disease, and they are not made airborne without extraordinary effort.

Thus, the citation of large numbers of fibers in settled dust samples is a diversion from the recognition, evaluation and control paradigm of the Industrial Hygiene Field. At least since the 1950's, the industrial hygiene profession has recognized and instructed that to evaluate exposure to airborne particulates or fibers, air sampling is required and that surface dust sampling cannot be used as a surrogate for air sampling. Particle or fiber concentrations in air are measured in the breathing zone. There are no procedures to measure settled dust for assessment of inhalation risk due to insoluble dusts such as asbestos. For insoluble dusts such as asbestos, there is no official or professional assessment method for concluding health risk does or does not exist based on settled dust sampling and sample analysis*

The reason for not using settled dust measurements to arrive at conclusions about inhalation risk is that such measurements do not correlate with the airborne material that may breathed (Chatfield, E.J.: Correlation Measurements of Airborne Asbestos-Containing Particles and Surface Dust. Advances in Environmental Measurement Methods for Asbestos. American Society of Testing Materials, Conshohocken, PA. Jan. 2000, pp. 378-402; Lee, R.J., Van Orden, D.R. and Stewart, I.M.: Dust and Airborne Concentrations-Is there a Correlation? Advances in Environmental Measurement Methods for Asbestos. American Society of Testing Materials, Conshohocken, PA. Jan. 2000, pp. 313-322). There is no way of predicting what may appear in the air from knowledge of what is on the surface. Those suggesting that measurements of asbestos in settled dust are related to "contamination" with associated implications for health risk are counting upon others to visualize the mass release of fibers from the floor to the air, which can then be inhaled. It simply does not happen that way.

*Settled dust is, however, evaluated for materials that are soluble, materials that after touching can adhere to the hand. When inserting the hand into the mouth, a soluble toxic material can enter the body via the gastrointestinal tract. This type of assessment is performed for soluble lead, where children may be exposed to inordinate levels of lead dust on floors of lead painted homes; the lead dust is soluble in body fluids. We also use this evaluation method for polychlorinated biphenyl hydrocarbons (PCB's) where absorption can occur through the skin after skin contact with PCB's on a solid surface such as a table. To attempt (or pretend) to apply these methods to assess inhalation risk in the different circumstances of insoluble particulates or fibers, such as asbestos, is unprofessional and intellectually dishonest.

The extensive use of settled dust measurements in lawsuits involving recovery of alleged damage from asbestos-containing materials in buildings is a measurement and a procedure created for the courtroom. It is not scientific, and it is not interpretable in terms of risk to health from airborne asbestos.

VIII. Summary and Conclusions.

Review of available investigations of potential homeowner exposure to ZAI, as well as review of an EPA Region VIII risk assessment, associated critiques of this assessment and other relevant documents, lead to the following conclusions:

- Zonolite™ Attic Insulation (ZAI) contains approximately 1% or less asbestos by weight. The bulk material can release airborne particles and fibers when poured or otherwise intruded upon with energy.

- A variety of investigations have been undertaken to measure the concentrations of asbestos-in-air when ZAI does release fibers to the air. Measurements have also been performed in homes when disturbance of ZAI did not occur. The measurements are consistent in that they indicate that disturbance duration is brief, if it occurs, and that airborne asbestos concentrations during disturbance are measurable in the breathing zones of those in the immediate vicinity of the disturbance, but are not elevated throughout the entire home. Where concentrations were elevated, they returned to background levels within hours after the disturbance activity.

  In the absence of disturbance, asbestos-in-air concentrations in homes are the same as background concentrations.

- The industrial hygiene model of recognition, evaluation, and control when applied to ZAI, indicates that there is a direct analogy between the nationwide concern for, and resolution of the potential health risks of asbestos-containing materials in buildings, and ZAI in homes. In the former case, after 11 years of data gathering and repeated lowering of estimates of risk to building occupants and maintenance workers, the EPA concluded the risk to be low, if it exists at all. In both cases, the asbestos bulk material remains undisturbed for the vast majority of its usage in-place. When disturbed with some form of energy, exposure is to those in the immediate vicinity of emissions and is for a very limited period time. In both cases, the dosage of inhaled fibers to the lungs is very low when compared to the historical lifetime dosages of asbestos inhaled in the past by asbestos workers, or to dosages permitted to be inhaled during a working lifetime with current occupational standards.

- Settled dust measurements are not a measure of inhalation risk and are not relevant to evaluation of ZAI potential health risk.

- Utilization of risk assessment methodologies to estimate "hypothetical risk" from homeowner exposure to the intermittent, short duration, low concentration exposure to airborne asbestos when it occurs, if it occurs, indicates risks less than those usually regulated by the EPA and not sufficiently high to be regulated by OSHA.

- A survey of resident health in Libby, Montana homes does not provide evidence that ZAI is associated with manifestations of asbestos disease in the population studied; worker exposure variables were associated with occurrence of asbestos disease. This investigation is consistent with evaluation of homeowner exposure to asbestos from ZAI and associated health risk, as presented in this report.

In addition to all of the above, I may also rely on, or in part, or comment on the publications, opinions, data and materials produced in discovery or contained in reports of other experts designated by the claimants or W.R. Grace in this action, and I reserve the right to amend or supplement this report, as necessary.

Appendices

A. Curriculum Vitae of Morton Corn

B. Notes of Inspections of Seattle Area Homes for ZAI (by Morton Corn)

C. Summary of M. Corn Testimony

CURRICULUM VITAE

Morton Corn

PERSONAL DATA

Home Address

3208 Bennett Point Road
Queenstown, MD 21658-1126
Phone: (410) 827-7305

Business Address

Morton Corn & Associates, Inc.
3208 Bennett Point Road
Queenstown, MD 21658-1126
Phone: (410) 827-3205
Fax: (410) 827-3206
Email: mjcorn@friend.ly.net

EDUCATION AND TRAINING

Degree	Year	Institution	Field
B.Ch.E.	06/55	The Cooper Union New York, NY	Chemical Engineering
M.S.	06/56	Harvard University Division of Engineering and Applied Physics Cambridge, MA	Industrial Hygiene and Sanitary Engineering
Ph.D.	01/61	Harvard University Division of Engineering and Applied Physics Cambridge, MA	Industrial Hygiene and Sanitary Engineering

Postdoctoral Training

National Science Foundation Postdoctoral Fellow, London School of Hygiene and Tropical Medicine, University of London, Medical Research Council, London, England, 1961-62.

Guggenheim Fellow, London, England, 1972-73.

Board Certification

Board of Certified Safety Professionals, Parkridge, Illinois (Certificate No. 1869).

PROFESSIONAL EXPERIENCE

Professor Emeritus, July 1, 1997 - present, The Johns Hopkins University, School of Hygiene and Public Health, Department of Environmental Health Sciences, Division of Environmental Health Engineering.

Professor and Division Director, February 1, 1980 - June 30, 1997, The Johns Hopkins University, School of Hygiene and Public Health, Department of Environmental Health Sciences, Division of Environmental Health Engineering; **Director**, July 1982 - June 1997, NIOSH Educational Resource Center in Occupational Safety and Health; **Director**, June 1990 - March 1996, National Institute of Environmental Health Sciences Research Center.

Assistant Secretary of Labor, December 2, 1975 - January 20, 1977, Occupational Safety and Health, United States Department of Labor, Washington, D.C.

Professor, August 1967 - December 1979, University of Pittsburgh, Department of Industrial
Environmental Health Sciences (formerly Department of Occupational Health) and Adjunct Professor, Department of Chemical Engineering; **Associate Professor**, June 1965 - August 1967, University of Pittsburgh, Department of Occupational Health; **Associate Professor**, September 1965 - July 1966, Department of Public Health Practice; **Assistant Professor**, September 1962 - September 1965; Department of Public Health Practice; **Adjunct Assistant Professor**, 1965, Chemical Engineering; **Visiting Fellow**, 1964-68, Mellon Institute (Industrial Hygiene Foundation).

Research Associate, September 1960 - August 1961, Harvard School of Public Health, School of Engineering and Applied Sciences. Joint appointment in Departments of Industrial Hygiene and Physiology.

USPHS Fellow, September 1958 - August 1960, Harvard School of Public Health, School of
Engineering and Applied Sciences.

Project Engineer, July 1956 - August 1958, Robert A. Taft Sanitary Engineering Center, United States Public Health Service, Cincinnati, Ohio. Military service fulfilled while Project Engineer. Presently in USPHS Inactive Reserve. Permanent Grade: Sanitary Engineer Director.

Research Aide, June 1954 - September 1954; United States Atomic Energy Commission, Health and Safety Laboratory, New York, NY.

PROFESSIONAL ACTIVITIES

Societies/Memberships

Delta Omega (Honorary Public Health), 1955-present

Air Pollution Control Association, Member 1957-1994; TR-1 Research Committee, 1966-67;

Member, Technical Council, 1973-75; Vice Chairman, Committee on Indoor Air Pollution, 1977

American Chemical Society: Member, Senior Grade, 1959-73; 1992-1997

Sigma XI: Senior Member, 1960-1989

British Occupational Hygiene Society, 1962-95

American Institute of Chemical Engineers: Member, Full Grade, 1963-1995

American Public Health Association: Fellow, 1964-

American Industrial Hygiene Association: 1959; Fellow and Honorary Member. Member, Technical Committee for Air Pollution Evaluation, 1964-67; Member, Technical Committee for Aerosol Technology, 1966-69; Member, Management Committee, 1982-85; Member, Long Range Planning Committee, 1990-95; Member, Risk Assessment Committee, 1995-97. Board of Directors, Elected Director, 2000-2003

Intersociety Committee for Standardization of Air Sampling Methods, Member, Sulfur Compounds Subcommittee, 1965-68

American Association of University Professors, 1967-91

American Conference of Governmental Industrial Hygienists, 1968-; Vice Chairman Elect, 1982; Vice Chairman, 1983; Chairman, 1984; Awards Committee, 1984-1990

American Association for the Advancement of Science, 1969-75; 1982-84

Society of Occupational and Environmental Health: Founding Member, 1972-86; Councilor, 1973-76; 1981-84; Chairman, NIOSH Criteria Document Review Committee, 1974-75; Chairman, Engineering Committee, 1975

Pan American Medical Association, 1975-76

American Thoracic Society, 1977-81

Collegium Ramazzini, 1983-

Society for Risk Analysis, 1987-97.

Permament Commission on Occupational Health, 1980-95

Society for Environmental Exposure Assessment, 1993-1997

Amer. Soc. Safety Engineers, 1973-

Participation on Advisory Panels

Federal, State and Local Government

Allegheny County, Pennsylvania Air Pollution Advisory Committee, 1967-72;
Chairman, Air Quality Subcommittee, 1967-69
USPHS, National Air Pollution Control Administration, Air Pollution Research Grants
Advisory Committee, Member, 1968-72; Chairman, 1969-72
National Research Council, National Academy of Sciences Committee on Biological Effects
of Air Pollution, Member, 1970-71

PROFESSIONAL ACTIVITIES

Participation on Advisory Panels

Federal, State and Local Government (cont'd)

U.S. Department Health, Education and Welfare, NIH, Special Studies Section (Grants Review), Member, 1974-75

National Research Council, National Academy Engineering Committee on Air Pollution and Stationary Source Control, Member, 1974-75

Environmental Protection Agency, Science Advisory Board, 1975; 1977-81; 1982-85

National Institute of Occupational Safety and Health, Testing and Certification Committee, 1979

National Advisory Committee on Vital and Health Statistics, DHEW, Washington, DC 1979-81

National Academy of Sciences, Committee on Institutional Means of Risk Assessment, 1981-82

Office of Technology Assessment Committee on Control Technologies in the Workplace, Chairman, 1982-83

Governor's Toxic Substances Advisory Board, State of Maryland, 1982-85

Office of Technology Assessment, Committee on Cleanup of Uncontrolled Hazardous Waste Sites Under Superfund, 1983-85

National Science Foundation Project on State of the Art of Risk Assessment, Member of Advisory Committee, 1984

Maryland Long Range Environmental Planning Committee, State of Maryland, Baltimore, MD, 1985-87

National Cancer Institute, Advisory Board on Methylene Chloride Epidemiological Study, Member, 1986-87

Mine Health Advisory Committee, Member. National Institute of Occupational Safety and Health, Atlanta, GA, 1986-89

Governor's Toxic Council, State of Maryland, Chair, 1986-89; Member, 1990-1991

Office of Technology Assessment Committee on Cleanup of DOE Weapons Production Sites, Member, 1989-90

Office of Technology Assessment, Committee on Economic Aspects of OSHA Regulation, Member, 1993-94

Department of Energy, Tank Advisory Panel (Hanford Site), Pascoe, WA, 1993-1999

U.S. Department of Energy, Los Alamos National Laboratory, Environment Division Advisory Committee, 1994-97

PROFESSIONAL ACTIVITIES

Consultations

Governmental Agencies

U.S. Atomic Energy Commission, Division of Biology and Medicine, Washington, DC, 1964-66; Oak Ridge National Laboratory, 1964-66; Los Alamos Scientific Laboratory, Industrial Hygiene Group, 1964-1975; Idaho Falls Reactor Test Site, Health and Safety Division, 1967

U.S. Public Health Service, Division of Air Pollution, Laboratory of Engineering and Physical Sciences, 1964-68

Allegheny County Bureau of Air Pollution Control, 1964-70

U.S. Bureau of Mines, Health and Safety Division, 1965-72

Department of Environmental Resources, Commonwealth of Pennsylvania, 1971-72

WHO, Sao Paulo, Brazil, August, 1974

U.S. Department of Health, Education and Welfare, National Institutes of Health, Special Studies Section, 1974-75

Tennessee Valley Authority, Division of Environmental Planning, Chattanooga, Tennessee, 1974-75

Science Advisory Council of Canada, Ottawa, Canada, 1977

National Institute of Environmental Health Sciences, Bethesda, MD 1977

National Institute of Occupational Safety and Health, 1981

General Services Administration (GSA), 1981-83

Environmental Protection Agency, 1981-84

Office of Technology Assessment (OTA), 1982, 1984, 1989

CETESB, Sao Paulo, Brazil, 1983

U.S. Department of State, 1983

U.S. General Accounting Office, 1984-85

U.S. General Services Administration, 1984-85

U.S. Library of Congress, 1985

Occupational Safety and Health Administration (Training Institute), Des Plains, IL, 1986-1992

State of Kentucky Corrections Office, 1988

U.S. Occupational Safety and Health Administration, Health Standards Directorate, Washington, DC, 1990; 1992

U.S. Department of Energy, Los Alamos Scientific Laboratories, Environmental Restoration and Waste Management Advisory Committee, 1993-94

U.S. Department of Energy, Hanford Tank Advisory Panel Subcommittee on Tank Vapors, Richland, WA, 1993-1999

National Institutes of Health, 1993

U.S. Army, Fort Meade, MD, 1993

U.S. Department of Energy, Washington, D.C., Office of Health, Safety and Environment, 1994-97.

PROFESSIONAL ACTIVITIES

Consultations (cont'd)

Private and Non-Profit Organizations

Industrial Hygiene Foundation, Mellon Institute (Visiting Fellow), 1964-68

In this capacity, consultation and services were provided for the following industries:

St. Joseph Lead Company, Monaca, PA, 1965
Perkin-Elmer Corporation, Norwalk, CN, 1965
Pittsburgh Plate Glass Company, Pittsburgh, PA, 1965
Owens-Corning Fiberglas Corporation, Newark, OH, 1965-66
International Nickel Company, Huntington, WV, 1965-67
Dravo Corporation, Neville Island, PA, 1967
Butler County Mushroom Farm, Winfield, PA, 1967
Westinghouse Airbrake Company, Pittsburgh, PA, 1967
Homer-Laughlin China Company, Newell, WV, 1968
Electric Power Research Institute, Palo Alto, CA, 1974
Harvard University School of Public Health (Respiratory Disease Study), 1974-84
Oakland University, Oakland, MI, 1977
Mellon Institute of Science, Carnegie-Mellon University, Pittsburgh, PA, 1977-78
University of Toronto (Chemical Engineering and Applied Chemistry Department), Toronto, 1977-78
Wayne State University, Detroit, MI (Toxicology Course), 1977-82
Carnegie-Mellon University, Post Professional Education Center, Pittsburgh, PA, 1977-85

Canadian Chemical Producers Association, Montreal, 1978
Bituminous Coal Operators Association, Washington, D.C., 1978
New York University, Institute of Industrial Medicine, New York, NY, 1978-80
American Mining Congress, Washington, D.C., 1978, 1981, 1984
Pennsylvania State University, State College, PA, 1979
Brookings Institution, Washington, D.C., 1979-81, 1983
American Petroleum Institute, Washington, D.C., 1979, 1985
Universities Associated with Research and Education in Pathology (UAREP), 1984
Thermal Insulation Manufacturers Association, Member, Advisory Committee, 1984
Project on Health Effects of Hazardous Waste Sites, Bethesda, MD, 1984
Safe Buildings Alliance, Washington, D.C., 1985
Clean Sites, Incorporated, Alexandria, VA, (Chair, Technical Advisory Board), 1985-88
Gypsum Association, Chicago, IL, 1985
The Refractories Institute, Pittsburgh, PA, 1986-92
Harvard University Health and Safety Office, Cambridge, MA, 1986-88
Manufacturing Chemists Association, 1987
Aluminum Association, Washington, D.C., 1987
Health Effects Institute, Cambridge, MA, 1988

PROFESSIONAL ACTIVITIES

Consultations

Private and Non-Profit Organizations (cont'd)

GM/UAW Health Advisory Committee, Detroit, MI, 1988-92
Georgetown University, Epidemiology Center, Washington, DC, 1989-92
Associated Universities, Washington, DC, Member, Board of Trustees, 1991-93
Carpet and Rug Institute, Dalton, GA 1993-96
University of Calgary, Calgary, Canada, 1994
Institute for Polyacrylate Absorbents, Washington, DC, 1994; 1996; 1999
China Industrial Information Institute, Washington, DC, Secretary, 1996-
Howard Hughes Medical Institute, Washington, DC, 1999

Consulting Firms

Hemeon Associates, Pittsburgh, PA, 1962-63
CONTECSA, Buenos Aires, Argentina, 1972
Macro Systems, Silver Spring, MD, 1974-75
A.D. Little, Incorporated, Cambridge, MA, 1975

Engineering Science, McLean, VA, 1977
NUS, Rockville, MD, 1977
Bolt, Beranek and Newman, Cambridge, MA, 1977-78
O'Donnell Associates, Pittsburgh, PA, 1979
Green International, Incorporated, Sewickley, PA, 1979
TRC of New England, Hartford, CT, 1979
Clayton Environmental Consultants, Southfield, MI, 1979-82, 1985-89; 1990; 1998
Engineering Research and Technology, Concord, MA, 1980
Consultants in Epidemiology and Occupational Health, Washington, DC, 1984-85
Regulatory Resources, Incorporated, Toledo, OH, 1985
Circadian Technologies, Incorporated, Wellesley, MA, 1987
ICF/Clements, Inc., Washington, DC, 1991
Weinberg Group, Washington, DC, 1992
Science International, Inc., Arlington, VA, 1993-1996
Dames and Moore, Denver, CO, 1994
Paragon Technical Services, Inc., Albuquerque, NM, 1994-1996
Economic Research Services, Tallahassee, FL, 1999-

Legal and Insurance Firms

Glasso and Kachulis, Attorneys-at-Law, Pittsburgh, PA, 1964
Continental Insurance Company, 1967
Reed, Smith, Shaw and McClay, Pittsburgh, PA, 1968, 1998, 1999,2000
Rose, Schmidt and Dixon, Pittsburgh, PA, 1968
Jones, Gregg, Creehan and Gerace, Pittsburgh, PA, 1971
Technical Advisory Service for Attorneys, Pittsburgh, PA, 1971

PROFESSIONAL ACTIVITIES

Consultations

Legal and Insurance Firms (cont'd)

Stites, McElvain and Fowler, Louisville, KY, 1975
Haynesworth, Perry, Bryant, Marion & Johnstone, Greenville, SC, 1979
American Insurance Company, Pittsburgh, PA, 1979
Shea and Gardner, Washington, DC, 1980
Hamel, Park, McCabe and Saunders, Washington, DC, 1981
Hunton and Williams, Richmond, VA, 1981
Morgan, Lewis and Bockius, Philadelphia, PA, 1982-1997; 2000
Cadwalader, Wickersham & Taft, NY, 1983, 1990
Kirkland and Ellis, Washington, DC, 1985, 1992, 2002

Foley, Hoag and Eliot, Boston, MA, 1986
Hoyle, Morris and Kerr, Philadelphia, PA, 1986-90, 1993-1999
Goodwin, Proctor and Hoar, Boston, MA, 1987-89
Sewell and Riggs, Houston, TX, 1988
Venable, Baetjer and Howard, Baltimore, MD, 1989-91, 1999, 2000
Arter and Hadden, Columbus, OH, 1989; 1991-92; 1994-95
Quinn, Ward and Kershaw, Baltimore, MD, 1991
Willman and Arnold, Pittsburgh, PA, 1991-1995
Jackson and Kelly, Washington, DC, 1991-93
Hardin, Cook, Lopez, Engel and Bergez, Oakland, CA, 1991-92; 1995-96
Brown, Sims, Wise & White, Houston, TX 1993
Kean, Miller, Hawthorne, D'Armond, McCowan & Jarmen,
Baton Rouge, LA, 1993, 1994, 1998, 1999, 2000, 2001, 2002
Sugden, McFee & Roos, Vancouver, B.C., 1992-93
Akin, Grump, Strauss, Hauer & Feld, Washington, DC, 1993-95, 1998
Hill, Fulwider, McDowell & Matthews, Indianapolis, IN, 1993
Macaulay and McColl, Vancouver, B.C., 1994
Crowell and Moring, Washington, DC, 1994-
Israel and Wood, Pittsburgh, PA, 1994
Babst, Calland, Clements and Zomnir, Pittsburgh, PA, 1994
Coblence and Warner, New York, NY, 1994-95
Allstate Insurance Company, Chicago, IL, 1995
Skadden, Arps, Meagher, Slate and From, New York, NY 1994, 1998, 1999
King and Spalding, Washington, DC, 1995, 2000, 2001, 2002
Church and Houff, Baltimore, MD, 1996
Fulbright and Jaworski, Houston, TX 1996
Patton-Boggs, Washington, DC, 1995-96; 1997, 1999
Adler, Pollock and Sheehan, Inc., Providence, RI, 1996
C. Marshall Friedman, St. Louis, MO, 1996
Covington and Burling, Washington, DC, 1996
Stevenson, Rusin & Friedman, Chicago, IL, 1997

PROFESSIONAL ACTIVITIES

Consultations

Legal and Insurance Firms (cont'd)

Bergeson and Campbell, Washington, DC, 1997
Williams, Kastner and Gibbs, Seattle, WA, 1997
Shackleford, Farrior, Stallings and Evans, Tampa, FL, 1997-98

Forman, Perry, Watkins, Krutz and Tardy, 1997-98; 2002
Baker and Botts, Houston, TX, 1998
Vorys, Sater, Seymour and Pease, Columbus, OH, 1998, 1999, 2000, 2001
Wilson, Elser, Moskowitz, Edelman and Dicker, Newark, NJ, 1998-
Obermayer, Rebmann, Maxwell and Hippel, Philadelphia, PA, 1998-1999
Steptoe and Johnson, Washington, DC, 1998-1999; 2000, 2001, 2002
Mayor, Day, Caldwell and Keeton, Houston, TX 1998-1999
Foley and Lardner, Chicago, IL, 1998-1999
Latham and Watkins, Los Angeles, CA, 1999-
Calwell and McCormick, Charleston, WV, 1999-2001
Mathhiesen and Chase, Houston, TX, 1999
Hinshaw and Culbertson, Chicago, IL, 1999, 2001, 2002
Jones, Day, Reeves and Pogue, Washington, DC, 1999, 2000
LaBoeuf, Greene and MacRae, Washington, DC, 1999-2000
Ropes and Gray, Boston, MA, 1999-2001
King & Spalding, Atlanta, GA., 2000
Lemle & Kelleher, New Orleans, LA, 2000, 2001
Jenkins & Gilchrist, Dallas, Texas, 2000-2001
Hahn, Loesser & Park, Columbus, Ohio, 2000
Deutsch, Kerrigan & Stiles, New Orleans, LA, 2001-2002
Siegel & Naprekowski, Cherry Hill, New Jersey, 2001
Jackson & Walker, Houston, TX, 2001-
Gibson, Dunn & Crutcher, Washington, DC, 2001
Gollatz, Griffin & Ewing, Philadelphia, PA, 2001
Wilbraham, Lawler & Buba, Philadelphia, PA, 2001
Simon, Peregrine, Smith & Redfearn, New Orleans, LA, 2001
Wilcox & Savage, Norfolk, VA, 2001-
O'Melvany & Myers, San Francisco, CA, 2001-
Spilman, Thomas & Battle, Charleston, W. Va., 2001-2002
Dickinson Wright, Detroit, MI, 2001-
Brobeck, Phleger, Harrison, San Francisco, CA, 2001-
Hawkins & Parnell, Atlanta, GA, 2001-
Dickie, McCamay & Chilcote, Pittsburgh, PA, 2001-
Reed, Smith, Shaw & McClay, Pittsburgh, PA, 2001, 2002
Greenberg Taurig, Chicago, Ill., 2001-
Edwards & Angell, New York, N.Y., 2002
St. Peter Law Group, San Francisco, CA, 2002

Legal and Insurance Firms (cont'd)

Arent Fox, Washington, D.C., 2002
Butler, Rubin, Sattarell and Boyd., Chicago, Ill., 2002
Baker & Botts, Houston, Texas, 2002

Industrial Firms

Bird Industries, Newton, MA, 1961
Boston Radio Corporation, Boston, MA, 1961
Union Industrial Equipment Company, Fall River, MA, 1963-69
Crucible Steel Corporation, Pittsburgh, PA, 1966
Brooks Instrument Company, Hatboro, PA, 1966
Harbison-Walker Refractories Corporation, Pittsburgh, PA, 1966
Syntex Research Corporation, Palo Alto, CA, 1967
Ferro Corporation, Pittsburgh, PA, 1967
Becton-Dickinson Corporation, East Rutherford, NJ, 1967-68, 1972, 1981, 1986-89
United States Steel Corporation, Pittsburgh, PA, 1968
Ohio River Barge Company, Pittsburgh, PA, 1968
Consolidated Coal Company, Pittsburgh, PA, 1968
DuPont Company (Chambers Works), Wilmington, DE, 1968
Pittsburgh Plate Glass Company, Resins and Coatings Division, 1969
Pittsburgh Plate Glass Company, Plate Glass Division, 1969
Hanes Corporation, Winston-Salem, NC, 1969-70
Resources Research, Incorporated, Reston, VA, 1969-70
Pittsburgh-Corning Corporation, Pittsburgh, PA, 1969-70
Monterey Coal Company, Carlinville, IL, 1969-70
Baltimore Biological Lab (BBL), Cockeysville, MD, 1971
Pittsburgh Metals Purifying Company, Saxonburg, PA, 1972
International Nickel Company, Huntington Alloy Products Division, Huntington, WV, 1972, 1975
Sierra-Permaneer Corporation, Pittsburgh, PA, 1973
Thermal Insulation Manufacturers' Association, 1973, 1979-80
Witco Chemical Company, Bedford, PA, 1974
National Paint and Coatings Association, Washington, D.C., 1974
Eastern Associated Coal Corporation, Pittsburgh, PA, 1974
ARCO/Polymers Corporation, Philadelphia, PA, 1974
Ethyl Corporation, Baton Rouge, LA, 1974
Duquesne Light Company, Pittsburgh, PA, 1974
Royston Laboratories, Blawknox, PA, 1975
Environmental Research and Technology, Incorporated, Concord, MA, 1975
Corhart Refractories Company, Louisville, KY, 1975
National Industrial Sand Association, Silver Spring, MD, 1975, 1977-78, 1981
Mobay Chemical Company, Pittsburgh, PA, 1977
NUS Corporation, Rockville, MD, 1977
General Electric Company, Materials and Components Group, Pittsfield, MA, 1977
UOP, Incorporated, Des Plaines, IL, 1977-1994

Wilson Products, Incorporated,, Reading, PA, 1977-78
EXXON, Floral Park, NJ, 1977-78
General Electric Company, Engineered Materials, Columbus, OH, 1977-81
IBM, Armonk, NY, 1977-82, 1984-85
Westinghouse Electric Corporation, Pittsburgh, PA, 1978
Donaldson Company, Minneapolis, MN, 1978
Vesuvius Crucible Company, Pittsburgh, PA, 1978
Alcan, USA, Cleveland, OH, 1978-81, 1983-84, 1986-87
Pennsylvania Glass Sand Company, Berkeley Springs, WV, 1979
Western Electric Company, Princeton, NJ, 1979
CIBA-Geigy Corporation, Ardsley, NY, 1979-80, 1987
Owens-Corning Fiberglas Co., Toledo, OH, 1979, 1985, 1987, 1989
Calgon, Pittsburgh, PA, 1980-81
Dana Corporation, Victor Products Division, Lisle, IL, 1981
American Mining Congress, Washington, D.C., 1981
Johns Manville Corporation, Denver, CO, 1981, 1986
United States Gypsum, Chicago, IL, 1982-
General Electric Company, Silicone Products Division, Waterford, NY, 1982, 1984
Kendall Corporation, Boston, MA, 1983
Carlisle Corporation, Butler, PA, 1983
Catalyst Recovery, Incorporated, Baltimore, MD, 1984
Katalistics, Incorporated, Baltimore, MD, 1984
A.P. Greene Company, Mexico, Missouri, 1984-85; 1988; 1990
Petro-Canada, Calgary, Canada, 1985
SCM Company, New York, NY, 1985-86
Consolidated Ceramics, Incorporated, Cincinnati, OH, 1985, 1987
Tambrands, Incorporated, Springfield, MA, 1986
Atlantic Richfield Corporation, Los Angeles, CA, 1986
The Wilkerson Group, New York, NY, 1986
W.R. Grace Corporation, Cambridge, MA, 1986, 2001
U.S. West, Information Systems, Incorporated, Denver, CO, 1986-87
Manville Corporation, Denver, CO, 1987
E.I. DuPont de Nemours, Wilmington, DL, 1987
ALCOA, Pittsburgh, PA, 1987

PROFESSIONAL ACTIVITIES

Consultations

Industrial Firms **(cont'd)**

Lonza Chemical, Fairlawn, NJ, 1988
Gates Energy Products, Gainsville, FL, 1988

Masonite Company, Raleigh, NC, 1988
EDS, Herndon, VA, 1989
Charles E. Smith Companies, Washington, D.C., 1989
Biospherics, Rockville, MD, 1989
ARCO, Los Angeles, CA, 1989
International Nickel Company, Wright Beach, NC, 1990
Exxon, New Orleans, LA, 1990, 1994-96
Purex Company, Gardena, CA, 1990-91
Corning Glass Company, Corning, NY, 1991
Mobil Oil Corporation, Princeton, NJ , 1992; 1999
Carborundum Corporation, Niagra Falls, NY, 1992-95
Schuller International, Inc, Denver, CO 1994
Honda Manufacturing of America, Inc., Marysville, OH 1994-95; 1999; 2000; 2001
Hoechst-Celanese, Charlotte, NC, 1995
Unifrax, Inc., Niagra Falls, NY, 1995-
M&M Mars, Inc., Hackettstown, NJ, 1996; 1997
James Hardie, Inc., Fontana, CA, 2000
Virginia Mirror Co., Martinsvile, VA, 2001
Kimberly Clark Co., Atlanta, GA, 2001-2002

Testimonies - Never Recorded

EDITORIAL ACTIVITIES

Editorial Board Membership

Advisory Editor, Atmospheric Environment (Pergamon Press), 1967-1986
Member, Editorial Board, Air Pollution Control Association Journal, 1968-85
Associate Editor, Environmental Letters (M. Dekker, Publishers), 1969-1996
Editorial Board, Excerpta Medica, 1971-1985
Member, Editorial Board, Annals Occupational Hygiene, London, 1973-1993
Chairman of Editorial Board, American Industrial Hygiene Association Journal, 1978-1980
Member, Editorial Board, American Journal Industrial Medicine, 1980-1998
Member, Editorial Board, Applied Industrial Hygiene, 1985-1990
Member, Editorial Board, Applied Occupational and Environmental Hygiene, 1991-
Member, Editorial Board, Regulatory Toxicology and Pharmacology, 1996-1998

HONORS AND AWARDS

New York State Regents Scholarship, 1951-55
A.I.Ch.E. Student Content Problem Honorable Mention, 1955

American Institute of Chemists Student Chemistry Award, 1955
USAEC Fellowship (Industrial Hygiene Engineering), 1955-56
National Science Foundation Honorable Mention, 1958
U.S. Public Health Service Traineeship, 1958-60
National Science Foundation Post-Doctoral Fellowship, University of London, 1961-62.
U.S. Delegate, International Atomic Energy Panel of Experts on Aerosols, Vienna,
Austria; July, 1967
Award for Best Paper Published in American Industrial Hygiene Association Journal, 1969.
WHO Fellowship (South America), 1970
Pittsburgh Chemists' Club and Technical Editors Society Best Paper Competition;
Honorable Mention, 1971
Appointed Member, Permanent Commission and International Association on Occupational
Health, Milan, Italy, 1972
John Simon Guggenheim Fellowship (London), 1972-73
Appointed Member, Panel of Experts on Occupational Health, WHO, Geneva, Switzerland,
1973-77, reappointed 1978-83; 1983-86; 1986-92; 1992-96
Elected Councillor, Society for Occupational and Environmental Health, 1973-76, 1981-84
Invited Participant, Workshop on Biological Effects of Fibers, IARC, Lyon, France,
June 1977
Invited Lecturer, Working Environment '77, Jonkoping, Sweden, 1977
Invited Participant, International Conference on Asbestos, Johannesburg, South Africa, 1977
American Lung Association Lecturer, Hawaii, February-March 1978
Invited Lecturer, VI International Conference on Pneumoconiosis, Caracas, Venezuela, 1978
WHO Consultant, Geneva, Switzerland, November 1979; April 1981; December 1982; December 1983
Appointed Civilian Adviser (Bioenvironmental Engineering) to the Surgeon General of the
U.S. Air Force, 1980-84
Invited Conference Speaker, Triennial Meeting of Permanent Commission on Occupational
Health, Cairo, Egypt, 1981; Dublin, Ireland, 1984
Elected Vice Chairman (succeeded to Chairman in 1983), American Conference of
Governmental Industrial Hygienists, 1981

WHO Consultant, Alexandria, Egypt, October 1981
WHO Consultant, Geneva, Switzerland, April 1982
Invited Speaker (Conference Address), British Occupational Hygiene Society Annual Meeting, London, England, April 1982
Invited Speaker and Session Chairman, International Conference on Biological Effects of Man Made Mineral Fibers, Copenhagen, Denmark, April 1982
Appointed Chairman, Industrial Hygiene Committee, Permanent Commission on Occupational Health, 1982
Elected Chairman, American Conference of Governmental Industrial Hygienists, 1982
Invited Speaker, Royal Society of Chemistry Annual Congress, Lancaster, England, 1983
Invited Speaker (Conference Address), Annual Meeting of Public Health Association of Nova Scotia, Halifax, N.S., October, 1983
Invited Lecturer, Institute of Health, National Academy of Medical Sciences, Beijing, Peoples Republic of China, (sponsored by Emory Foundation, Atlanta, GA), November 1983
Elected Member, Collegium Rammazini, 1983
Invited Participant, Banbury Center Workshop on Risk Assessment, Cold Spring Harbor, NY, May, 1984

Elected President, Association of Universities in Occupational Safety and Health, 1984.
Invited Speaker and Panel Member, National Symposium on Occupational Safety and Health, Atlanta, GA, May 1985
Cummings Award for Outstanding Contributions to Industrial Hygiene, American Industrial Hygiene Association, Dallas, June 1986
Golden Apple Teaching Award, School of Hygiene and Public Health, Johns Hopkins University, 1986
Chair, International Conference on Training and Education in Industrial Hygiene, Luxembourg, June 1986
Invited Faculty Member, Workshop on Byssinosis in the Far East, Hong Kong, November, 1986
Invited speaker, Third International Conference on Occupational Lung Diseases,

Montreal,
Canada, October, 1986
Member, International Agency for Research on Cancer, Working Group on Man-Made
Mineral Fibers, Lyons, France, June, 1987
Invited Participant, Workshop on Work, Health and Productivity, Johns Hopkins University,
Aspen-on-Wye, October 1987
Invited Speaker, Aluminum Association Annual Health and Safety Meeting, Tampa, FL,
December 1987
Invited Lecturer, OSHA Training Institute, Des Plains, IL, 1987; (3 occasions); 1988
(3 occasions); 1989 (3 occasions); 1990 (2 occasions); 1991 (2 occasions); 1992 (1 occasion)
Member, General Motors/United Autoworkers Occupational Health Advisory Board,
January, 1988-June, 1992
Invited Speaker, Symposium on Health Aspects of Exposure to Asbestos in Buildings,
Harvard University, Kennedy School of Government, December, 1988
Invited Speaker, International Life Sciences Institute Symposium on Assessment of Inhalation
Hazards, Hanover, Germany, February 1989.
Invited Speaker, Workshop on Exposure Assessment, Linkoping, Sweden, April, 1990.
Invited Summarizer, International Workshop on Retrospective Exposure Assessment for
Occupational Epidemiology Studies, Virgina, April 1990.
Invited Speaker, Symposium on Health, Environment and Social Change, Taipei, Taiwan,
July, 1990.
Invited Speaker, Workshop on Case Studies in Exposure Assessment, Stockholm, Sweden,
September, 1990.
Invited Participant, Roundtable on Occupational Diseases, The Roscoe Pound Foundation,
Washington, DC, November, 1990
Appointed Trustee, Associated Universities, Washington, DC, 1991-94.
Invited Speaker, Workshop on Occupational Health, University of Bari, Bari, Italy,
June, 1991.
Invited Lecturer, Oslo, Norway, September, 1991.

Invited Speaker, Workshop on Teaching Occupational and Environmental Lung Disease,
Universities Associated with Research and Education in Pathology, Burlington, VT, 1991.
Invited Plenary Speaker, 8th International Conference on Occupational Lung Diseases, Prague, Czechoslovakia, September, 1992.
Invited Conference Summarizer, 7th Annual Professional Conference on Industrial Hygiene,
American Academy of Industrial Hygiene, Colorado Springs, CO, October, 1992.
Awarded Smyth Award by American Academy of Industrial Hygiene, Cincinnati,
OH, October, 1993.
Elected Fellow, American Industrial Hygiene Association, 1994.
Invited Speaker, Department of Energy Workshop on Biomarkers, Santa Fe, NM,
April, 1994.
Invited Lecturer, University of Calgary, Calgary, B.C. (Canada), May, 1994.
Keynote Speaker, Chesapeake Chapter American Industrial Hygiene Association, Professional
Development Conference, Annapolis, MD, October 1994.
Keynote Speaker, Rocky Mountain Chapter, American Industrial Hygiene Association Annual Meeting, Denver, CO, 1995.
Invited Keynote Speaker, Australian Institute of Occupational Hygiene Annual Meeting,
Perth, Australia, December 1996.
Elected Honorary Member, American Industrial Hygiene Association, 1996.
Invited Lecturer, Northwestern University School of Medicine, Chicago, IL, 1997.
Invited Lecturer, University of Oklahoma, School of Public Health, Oklahoma City, OK, 1997.
Elected to Board of Directors, American Industrial Hygiene Association, 2000
Invited Lecturer, Univ. S. Florida, Tampa, FL, October 2000
Meritorious Achievement Award, ACGIH, New Orleans, LA, 2001
Invited Speaker, DRI Seminar on Asbestos, Phoenix, AR, 2000
Invited Speaker, Organization Resource Counsellors, Wash, DC, 2002

Listings: Who's Who in the East
Who's Who in America
World Who's Who in Science
American Men and Women of Science

PUBLICATIONS

Books

Corn, M.: Translation Editor: Zimon, A.D., Adhesion of Dust and Powder, Plenum Publishers, New York, 1969.

Corn, M. and Corn, J. (eds.): Training and Education In Industrial Hygiene: ACGIH Annals. ACGIH, Cincinnati, OH, 1988.

Corn, M. (Editor): Handbook of Hazardous Materials, Academic Press, Inc., New York, 1993.

Book Chapters

Corn, M.: "Adhesion of Particles." Chapter XI in Aerosol Science, Davies, C.N., Ed., Academic Press, New York, 1966, pp. 359-392.

Corn, M.: "Non-Viable Particles in the Air." Chapter 3 in Revised 2nd Ed. Air Pollution, Volume 1, A.C. Stern, Ed., Academic Press, New York, 1968, pp. 47-94.

Corn, M.: "Aerosols and the Primary Air Pollutants - Non-Viable Particles - Their Occurrence, Properties, and Effects." Chapter 3, 3rd Ed. Air Pollution, Volume I, A.C. Stern, Ed., Academic Press, New York, 1976, pp. 77-168.

Corn, M. and N.A. Esmen: "Aerosol Generation." Chapter 2 in Handbook of Aerosols, ERDA, 1976, pp. 9-39.

Corn, M.: Regulatory Toxicology, Ch. 29 in Cassarett & Doull's, Toxicology, 2nd Ed. McGraw-Hill Book Co., New York, NY, 1980, pp. 710-726.

Hammad, Y.Y., M. Corn and V. Dharmarajan: "Environmental Characterization in Occupational Lung Diseases: Research Approaches and Methods. Weil, H. and Turner-Warwick, M., Eds. M. Dekker, Incorporated, New York, 1981, pp. 291-370.

Corn, M.: "Cotton Dust: A Regulators View" in Crandall, R.W. and Lave, L.B., The Scientific Basis of Health and Safety Regulation. The Brookings Institution, Washington, D.C., 1981, pp. 109-114.

Corn, M.: Strategies of Air Sampling. Chapter 18 in Recent Advances in Occupational Health, J.C. McDonald, Ed. Churchill Livingstone, London, pp. 199-209, 1981.

Corn, J. and Corn, M.: "The Control of Health Problems Related to Industrialization."
Chapter 8 in The Social Context of Medical Research. Wechsler, H., Lamont, Havers and Lahill, G.F., Jr. (Eds). Ballinger Pub. Co., Cambridge, MA. 1981, pp. 193-231.

Corn, M. and J.K. Corn: "The Impact of Federal Regulations on Occupational Physicians." Chapter 3 in Clinical Medicine for the Occupational Physician (M.H. Alderman and M.J. Hanley, Eds.), M. Dekker, New York, N.Y. 1982. pp. 37-50.

Corn, M., Billings, C.E. and Lees, P.S.: "Engineering Control of Occupational Safety and Health Hazards." In publication of same title, First, M.W. ed. NIOSH, Cincinnati, OH, 1983.

Corn, M.: "Industrial Hygiene Program Performance Standards." In Industrial Hygiene - The Future, Am. Conf. Govt. Ind. Hyg., Cincinnati, OH, 1983, pp. 99-104, 1983.

Corn, M.: "Regulating Toxic Substances: An Update." In Public Policy, Science and Environmental Risk, S. Panem, Ed. The Brookings Institution, Washington, DC, 1983, pp. 29-32.

Corn, J.K. and Corn, M.: "The History and Accomplishments of the Occupational Safety and Health Administration in Reducing Cancer Risks." Reducing the Carcinogenic Risks in Industry. Paul F. Deisler, Ed. Jr. Shell Oil Company, Houston, Texas, Marcel Dekker, Inc., New York and Basel, 1984.

Corn, M.: "Process of Standard Setting in Environmental Health". Occupational Lung Disease, Bernard, J., Gee, L., Keith, W., et al. Eds. Raven Press, New York,